1986

Implementation and evaluation of microcomputer systems for the Republic of Turkey's naval ships.

Ozkan, Sukru

NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

IMPLEMENTATION AND EVALUATION OF MICROCOMPUTER SYSTEMS FOR THE REPUBLIC OF TURKEY'S NAVAL SHIPS

by

Sukru Ozkan

March 1986

Thesis Advisor: Paul W. Callahan

ECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

a. REPORT SECURITY CLASSIFICATION	1b. RESTRICTIVE MARKINGS
a. SECURITY CLASSIFICATION AUTHORITY	3 DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution is unlimited
b. DECLASSIFICATION / DOWNGRADING SCHEDULE	
PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S)
a. NAME OF PERFORMING ORGANIZATION: Naval Postgraduate School 6b OFFICE SYMBOL (If applicable): Code 54	7a. NAME OF MONITORING ORGANIZATION: Naval Postgraduate School
c. ADDRESS (City, State, and ZIP Code): Monterey, California 93943-5000	7b. ADDRESS (City, State, and ZIP Code): Monterey, California 93943-5000
a. NAME OF FUNDING / SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
c. ADDRESS (City, State, and ZIP Code)	10 SOURCE OF FUNDING NUMBERS

PROGRAM ELEMENT NO.	PROJECT NO	TASK NO	WORK UNIT ACCESSION NO

TITLE (Include Security Classification)
IMPLEMENTATION AND EVALUATION OF MICROCOMPUTER SYSTEMS FOR THE REPUBLIC OF TURKEY'S NAVAL SHIPS

PERSONAL AUTHOR(S)
Ozkan, Sukru

13a TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (Year, Month, Day)	15 PAGE COUNT
Master's thesis	FROM _____ TO _____	1986 March	70

SUPPLEMENTARY NOTATION

COSATI CODES		
FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
Microprocessor, Microcomputer, Shipboard, Selection, Non-tactical, cost/benefit analysis

ABSTRACT (Continue on reverse if necessary and identify by block number)

The aim of this thesis is to analyze and design a microcomputer system for Republic of Turkish Navy combatant ships. Most shipboard nontactical information handling operations currently are performed manually aboard Republic of Turkish Naval combatant ships. To do this nontactical information handling operations efficiently, the development of a microcomputer system onboard RTN ship is presented. Also, microcomputer system design considerations and evaluation method will be discussed in this thesis.

DISTRIBUTION / AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a NAME OF RESPONSIBLE INDIVIDUAL Paul W. Callahan	22b TELEPHONE (Include Area Code) (408) 646-2634 22c OFFICE SYMBOL Code 52Cs

D FORM 1473, 84 MAR 83 APR edition may be used until exhausted
All other editions are obsolete

SECURITY CLASSIFICATION OF THIS PAGE

Approved for public release; distribution is unlimited.

Implementation and Evaluation of Microcomputer Systems for the Republic of Turkey's Naval Ships

by

Sukru Ozkan
Lieutenant Junior Grade, Turkish Navy
B.S., Turkish Naval Academy, 1980

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN INFORMATION SYSTEMS

from the

NAVAL POSTGRADUATE SCHOOL
March 1986

ABSTRACT

The aim of this thesis is to analyze and design a microcomputer system for Republic of Turkish Navy combatant ships. Most shipboard nontactical information handling operations currently are performed manually aboard Republic of Turkish Naval combatant ships. To do this nontactical information handling operations efficiently, the development of a microcomputer system onboard RTN ship is presented. Also, Microcomputer system design considerations and evaluation method will be discussed in this thesis.

TABLE OF CONTENTS

LIST OF FIGURES

I. INTRODUCTION

A. GENERAL INTRODUCTION

Microcomputers are reliable, efficient, low in cost and appropriate for a variety of applications. Computer systems have been used for many years aboard U.S Navy combatant ships to perform functions in support of both tactical and non-tactical operations.

A ship requires a great deal of administrative work and administrative correspondence in managing its assets, personnel, and equipment. Much of this work is repetitive, and time consuming, and is appropriate for computer implementation, leaving personnel to handle non-routine jobs. Paperwork and processing time can be significantly reduced by use of a computer.

Most shipboard non-tactical information handling operations currently are performed manually aboard Republic of Turkish Naval (RTN) combatant ships. A properly implemented microcomputer system should increase the productivity of ship's personnel by reducing routine shipboard paperwork.

The objective of this thesis is to outline an approach to determine what kind of microcomputer system design considerations there are, and what hardware is acceptable for existing, and projected, administrative applications on small ships. A "small ship " is defined as a ship which has a total crew of between 250 to 500 personnel. The approach could also be applied to other small shore based units.

B. THESIS OBJECTIVES

The objectives of this thesis are as follows :

1. Provide the reader an understanding of microcomputer system design considerations for the implementation of microcomputer systems for naval ships.
2. Provide the reader a method to evaluate microcomputers for non-tactical shipboard use.
3. Offer conclusions and recommendations concerning the results of the research.

C. SCOPE AND LIMITATIONS

1. Only currently available microcomputer systems will be considered.
2. Only non-tactical systems aboard RTN ships will be considered for possible automation.
3. There will be no financial limitation. However, a cost comparison will be made to determine the most cost effective system.

D. THESIS FORMAT

Chapter one presents the introduction and format of the thesis. Chapter two provides a general history of computers, and a history of U.S Navy's computer systems, and discusses the organization of RTN combatants. Chapter three describes Data Base Management System for RTN combatant ships, including Data base models and available DBMS to RTN. Chapter four examines system design considerations. Chapter five list the evaluation criteria for selecting a microcomputer system. Finally, Chapter six lists conclusions and recommendations.

II. BACKGROUND

A. HISTORY OF COMPUTERS

The rapid growth of microelectronic technology is revolutionizing the computer industry. Since the development of the vacuum tube ENIAC computer in 1946, computer technology has grown rapidly. The vacuum tube computers were the first-generation, and main storage consisted of a magnetic drum. These computers were huge and very hard to maintain. Programs were written in machine code. Vacuum tubes were replaced by transistors. The transistor was the technological breakthrough that brought forth the minicomputers of the 1960's and made possible the personal computer revolution of the 1970's. Transistorized computers were second-generation. Main memory was made of magnetic core. They were smaller and still very expensive. High-level languages were developed for programming, and rudimentary operating systems were invented. Discrete logic gates were developed and then combined and built into one chip or integrated circuits, introducing the third-generation of computers. [Ref. 1].

The INTEL 4004, The first microprocessor, was introduced in 1971. The main component of the microcomputer is the microprocessor. A microprocessor can be defined as a single Large Scale Integrated (LSI) chip or set of chips that performs the basic arithmetic and logical functions of a computer central processing unit (CPU). A microprocessor combined with memory and input/output control circuitry, is a microcomputer. Today's microprocessor is the equivalent of a 1950 roomful of circuitry [Ref. 2]. Current state of the

art is the fourth-generation computer, characterized by Very Large Scale Integration Computers VLSI circuity. Today's microcomputers are becoming cheaper, more compact, more efficient, and more powerful. Also, There is a general consensus that the computer is having a profound effect on our modern life.

In the near future, Fifth-generation computers will be developed. Users will be able to communicate with them in everyday conversational language, show pictures to them, transmit messages by keyboard or handwriting. [Ref. 3].

B. HISTORY OF U.S NAVY'S COMPUTERS

The AN/UYK-5(V) computer system was introduced to the U.S Navy in the mid-1960's to support maintenance and material management , SUADPS-207 (Shipboard Uniform Automatic Data Processing System - Special accounting class 207) and the accounting/financial functional areas [Ref. 4].

The AN/UYK-5(V) suite of hardware consists of five pieces of equipment. The computer was a second generation serial processor possessing 16K words of core, one quarter of which was dedicated to the executive or operating system. It had a magnetic tape unit of four transports and a controller; a card reader and a punch unit; a printer that had a sustained speed of 450 lines per minute and a keyboard teletype unit. This system was physically large occupying approximately 25 feet of wall space with each unit ranging from 2 to 3 feet deep; the central processor unit was six feet high. [Ref. 4].

For most of the AN/UYK-5(V) shipboard installations, the processing system was either at or near saturation, requiring the computers to run 24 hours a day, 7 days a week. The demand for computer services soon exceeded the system's physical capabilities. Compounding this problem was

a low tape transport reliability, a low effective printing rate of 450 lines per minute of the "High Speed" printer, and the system's physical deterioration due to advancing age.

SNAP-1 (Shipboard Non-tactical Automated Data Processing Program 1) was the U.S.Navy solution to the saturation problem. it filled the growing needs of the navy with modern computer hardware. The automation of administrative functions aboard ships resulted in increased efficiency of personnel use through time savings and increased accuracy of report generation. The SNAP-1 program consisted of hardware, software, and support services which will also meet future growth for non-tactical ADP requirements in several categories of floating and shore users.

SNAP 1 was divided in two phases. Phase 1 replaced the two troublesome pieces of AN/UYK-5(V) hardware (The magnetic tape drive and high speed printer were not sufficient). Phase 2, was going to be able to complete the replacement of all other AN/UYK-5(V) equipments [Ref. 5]. During implementation of phase 2, a 30 day operational test must be completed satisfactorily prior to acceptance of any further system deliveries. During the course of the tests, The Navy will ensure that the fail-safe requirements of the systems are met, including the validation of operator and maintenance training and preliminary familiarization course.

The U.S Navy began to replace the AN/UYK-5(V) system in the 1976. SNAP-1 supports large ships and shore commands. Some systems were discussed for small ships, Then The U.S Navy began a development program for small ships non-tactical microcomputer system in 1982 (SNAP-2). The purpose of SNAP-2 was to replace manual functions with automated systems to support the organizational, non-tactical requirements of small ships.

During the SNAP-1 phase, The U.S Navy leased a microcomputer based data management system (DMS). The microcomputer system on USS Coontz (DDG 40) and USS Arthur W. Radford (DD 968) was used over a 12-month period. The microcomputer system in both USS Coontz and USS A. W. Radford consisted of the following hardware :

1. Alpha Micro AM-1031 microprocessor system. Consisting of a western digital 16-bit central processing unit (CPU) with 256 KB MOS memory, 12 input/output ports, and a Control Data Corporation CDC-9427H disk drive unit with 5 KB fixed and 5 KB removable mass storage magnetic hard disks.
2. Digital Equipment Corporation DEC writer 3 LA-120 printer-terminal.
3. Qume daisy-wheel letter quality terminal-printer.
4. SOROC IQ-120 video display terminals. [Ref. 6].

The DEC writer LA-120 terminal-printer, and SOROC video display terminal were located in the lower combat information center (CIC) in USS Coontz and USS A. W. Radford. The rest of SOROC video display terminals were located in the weapons department, personnel, and supply offices aboard both ships. The Qume daisy-wheel letter quality terminal printers were located in each ship's administrative office. All cabling between Central Processing Unit and the peripheral devices used military standard three-pair shielded cable. The microcomputer system was powered by 60 Hz electric power. Power fluctuations were controlled by a constant voltage transformer (CVT) power supply and line filter.

The microprocessor systems support software provided both USS Coontz and USS A. W. Radford with a distributed, interactive, and time-sharing computer system for up to six users simultaneously. The operating system provided for quick system startup, user access security, use of command words and files for repetitive operations, and the higher level language used by the system.

USS Coontz and USS A. W. Radford were provided with a data management system (DMS). The DMS automatically provided for the creation, data entry, updating, and report generation from user-defined data files or data bases. The system also provided detailed documentation of file layouts and interrelationships between files.

A significant feature of DBM was its capability to establish predetermined record pointer files for various sorts required for either retrieving records by user-oriented keys (Individual's last name vice social security number) or for reporting data by desired sequences (duty section, life-raft assignment, projected rotation date, etc.) These pointer files were automatically updated by the database management system. Another significant feature of the DMS was its ability to allow users to easily define their own data files, to input data into single or multiple data files using a single-screen-formatted input function, and to output data, either from one or more data files, onto hard copy reports.

USS Coontz and USS A. W. Radford used a commercial word processing system (WPS), for general correspondence preparation and printing. Word Processing System; had the capability of creating, updating, printing, and deleting (1) Lists (for mailing labels and simple sorts), (2) Documents (letters and ship's instructions), and (3) standard paragraphs (those used in preparing the ship's plan-of the-day). [Ref. 6: p. 6]. Figure 2.1 shows the plan-of the-day.

The U.S Navy contracted Zenith Data Systems for a Zenith Z-120, then a TEMPEST version of their Z-150 model in 1984. The primary basic system included the 8088 microprocessor, 320KB RAM, a detachable 12 inch monochrome monitor, a detachable keyboard, dual DSDD 5-1/4 inch floppy disk drives, dot matrix printer, letter quality printer, Basic interpreter, and MS-DOS operating system. [Ref. 7].

SUNRISE: 0709 USS COONTZ (DDG 40) SUNSET: 1726
TIME ZONE: +5R FPO NEW YORK 09566 DUTY DIV: FOX
ELEC SAFETY COLOR: WHITE

PLAN OF THE DAY
Sunday 15, February 1981
Julian Date: 046
INPORT: NORFOLK, VA

FOR OFFICIAL USE ONLY DO NOT REMOVE FROM THE SHIP

UNIFORMS	OFFICER & CPO	ENLISTED
Working	Working Khaki Long Winter Working Blue	Dungarees/Utilities
Uniform of the Day	Service Dress Blue Winter Blue	Service Dress Blue Winter Blue
Liberty	Uniform of the Day App. Civilian Attire	Uniform of the Day App. Civilian Attire

DUTY OFFICERS		OOD WATCHBILL		DUTY SECTION FIVE	
CDO:	LTJG COSTA	08-12:	RMI THOMAS	DUTY MAA:	FTMI BIBEAULT
OPS:	LT SEXTON	12-16:	LT SEXTON	DUTY YN:	SN CHANDLER
WEPS:	FTMI EMERY	16-20:	FTMI EMERY	DUTY RM:	RM3 JACKSON
ENG:	MMI BARRS	20-24:	GMTI KING	DUTY SM:	QM2 GALLO
SUP:	SK2 WILSON	00-04:	EMI ALEMAN	DUTY DR:	RM3 JACKSON
X/N:	LTJG MILLER	04-08:	ENS HIGGENBOTHAM	SEC LDR:	DSC BARNETT

SHIP'S ROUTINE

Schedule is in accordance with the Routine of the Day as published in the SORM for Holiday Routine inport with the following exceptions:

0800 - MUSTER DUTY SECTION
0900 - OOD POS
1630 - DUTY INPORT FIRE PARTY [illegible]

HAPPY BIRTHDAY: NONE

ALL HANDS ARE RESPONSIBLE FOR THE CONTENTS OF THE POD

ORDERS OF THE DAY

1. STRIKER SELECTION BOARD. Membership of the Striker Selection Board shall consist of an enlisted representative from each department, minority representation, and shall include the master, senior, or chief petty officer of the command as chairman, and the command Career Counselor, when assigned. The senior personnelman assigned shall be a member (voting or non-voting) and shall provide qualification information to the board.

2. SECURITY NOTE. Espionage. There are no current indications of activity by hostile intelligence services in the Norfolk area. However, all COONTZ personnel should be alert to the fact that intelligence agents would likely concentrate their attention on personnel whose conduct (e.g., sexual promiscuity, need/greed for money, drug dealing, etc.) would make them vulnerable to blackmail. COONTZ personnel should avoid involvement in such compromising situations. COONTZ personnel must also promptly report to their superiors suspicious contacts with foreigners, or any request for defense information.

DC QUESTION. Q. What size plug is recommended for an 8" hole?
A. 10" plug

3M QUESTION. Q. If a monthly maintenance requirement was accomplished once during a quarter, is a notation required on the back of the quarterly schedule?
A. Yes

Figure 2.1 Plan-of-the-Day.

The second basic system included one 10 MB removable cartridge hard disk, one DSDD 5-1/4 inch floppy disk drives in addition to components of the primary basic system.

C. SYSTEM OVERVIEW IN THE TURKISH NAVY

Knowledge is power and the computer is an amplifier of that power. The Republic of Turkey Navy has felt the impact of the computer in its environment. As a result The RTN has installed the computer system in the Naval Academy.

RTN combatant ships have a great deal of administrative non-tactical work in managing their assets (personnel, data, and equipment) and communicating with those outside. Most of this non-tactical work is repetitive, and time consuming. These non-tactical information handling operations currently are performed manually by departments aboard RTN combatant ships. The RTN needs a shipboard computerized system aboard to allow personnel to concentrate on decision making and handling non-routine matters. These computerized systems would allow shipboard personnel the following advantages :

1. Administrative organization of personnel and equipment will be easier.
2. Job satisfaction and decision making capability will be improved.
3. The systems will reduce administrative workhours by as much as 50 %. In 1979 USS NIMITZ reported a 50% savings in administrative manhours utilizing word processors [Ref. 8].
4. Shipboard training will be improved.
5. The RTN is considering building a computer system at Golcuk. This system will allow the transfer of data between the shore based center and systems afloat, When the ships are in port.
6. The system will increase the quality of the ship's administrative functions by reducing errors and improving typing clarity.
7. This system will give computer literacy to the shipboard crew members. It will aid them to prepare for future use of other systems.
8. The replacement of manual procedures with less expensive automated procedures will decrease expenses.

9 It will save administrative time and labor over existing manual methods.

10 Productivity will be increased. Microcomputers allow user and commanding staff access to more data more quickly when making decisions.

The RTN shipboard organization has at least four departments;

1 Operations, including Navigation.

2 Weapons.

3 Engineering.

4 Supply, includes medical department.

Represention tasks of each department are:

1. Operationals Department

1 Plan monthly, quarterly operational department personnel training schedule according to the ship's main schedule,

2 Plan ship emergency situations and drills such as loss of generator, and loss of rudder control.

3 Prepare operational department's personnel files, including: name, rate/rank, schools attended, marital status, courses, previous duties, language ability, duty, others,

4 Assign duties to all operational department's personnel,

5 Plan current listing of equipment to be maintened by space, type, maintenance schedule, and personnel responsible,

6 Prepare personnel and equipment condition reports,

7 Prepare ship's movement reports.

2. Weapons Department

1 Plan monthly and quarterly personnel training schedules,

2 Plan current listing of all weapons to be maintained by a maintenance schedule by person responsible,

3 Prepare weapons department personnel files, including name, rate/rank, marital status, schools attended, courses, previous duties, language ability, duty, others.

4 Plan an ammunition inventory that includes the size, type and lot number of the ammunition on board, in addition to normal inventory control information.

5 Assign duties to all weapons department personnel,

6 Prepare monthly and quarterly weapons and personnel condition reports.

3. Engineering Department

1 Make fuel and water reports,

2 Plan the inventory control of the ship's technical spare parts,

3 Plan monthly and quarterly personnel training schedules,

4 Produce and monitor the planned maintenance checklist (daily, weekly, monthly and quarterly),

5 Prepare Engineering department personnel files (name, rate/rank, schools attended, marital status, courses, previous duties, language ability, duty, others..),

6 Prepare monthly and quarterly Engineering department's personnel and equipment condition reports.

4. Supply and Medical Department

1 Plan the inventory control of ship's technical spare parts, food and medical supplies,

2 Prepare payroll information reports (personnel name, rate/rank, marital status, payroll, travel expenditure),

3 Assign duties to all supply and medical department personnel,

4 Prepare demand periodic reordering of material, food, medicine, setting of reorder levels,

5 Prepare physical, dental examination blood-type and shot-record information.

These four departments plan their schedules according to the main ship schedule. The main schedule is part of the general administrative workload including:

1 Maintain all ship's personnel, equipment, weapons, food, medical files, records, and reports,

2 Prepare the plan-of-the day for the coordination and regulation of ship's activities and information of the crew,

3 Plan monthly, quarterly personnel training programs,

4 Assign duties to all personnel within the ship (Personnel responsible for watch assignments),

5 Prepare ship's daily, monthly, quarterly, yearly personnel, equipment, weapons reports,

6 Prepare public affairs file, including name, address, dependent's home addresses.

III. DATABASE MANAGEMENT SYSTEM

A. OVERVIEW

The personnel, personnel training, and equipment records are currently maintained manually by executive officers, personnel officers, training officers, and division officers in the RTN combatant ships. Personnel records, and routine reports are very repetitive and time consuming. To search and update these records is difficult. The work-flow diagram for these tasks is shown in Figure 3.1.

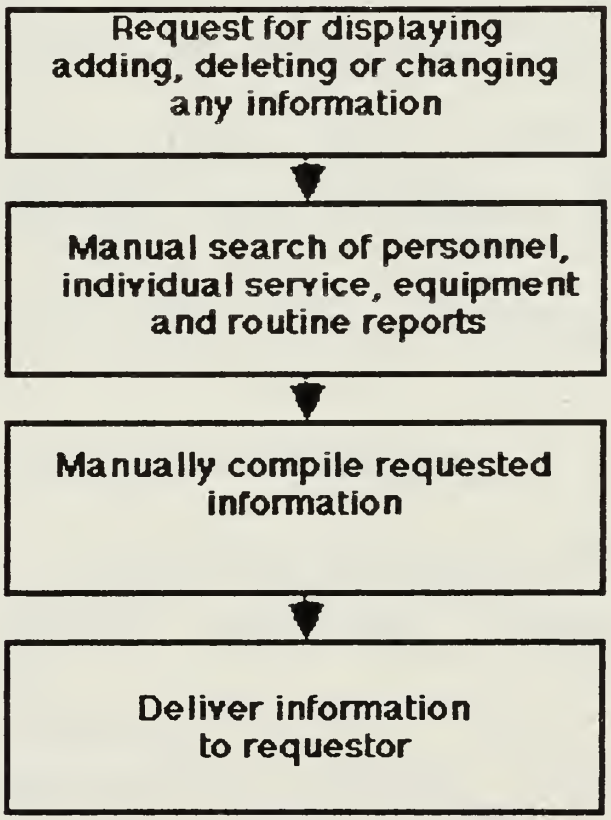

Figure 3.1 Manual Data Compilation Flow.

A DMS is necessary for (1) Personnel administration, (2) Ship's routine reports, (3) Maintenance and material management, and (4) Supply and medical inventory control applications. Users of data can be more efficient and effective with database processing; They can accomplish more within a fixed amount of time. A database is a collection of data files that are logically linked, independent of application software. "Logically Linked" refers to referencing with key expressions without the need of pointers or other underlying software referencing techniques. "Independent of application software" means the database reflects the inherent structure of the data, requiring no application interpretation or support [Ref. 9].

Personnel, equipment and routine report database management system will automatically provide the following advantages; [Ref. 10].

1. A DBMS allows more information to be extracted from the same data.
   a) Data consists of facts and figures.
   b) Information is knowledge gained by processing data for decision making.
2. A DBMS allows reduction or elimination of data duplication, allowing:
   a) A savings of storage requirements.
   b) More rapid processing and data entry.
   c) Enhanced data integrity.
3. A DBMS allows program-data independence.
   a) Programs do not have to be changed because the structure of the data changes.
   b) Different programs can have different "views" of data.
4. A DBMS allows better data management.
   a) Data dictionaries improve control over data.
   b) Data standards are easier to maintain.

5. A DBMS creates economies of scale.
   a) Improvements to the database benefit all users, not only the users of a particular application.
6. A DBMS allows easy data deleting, updating, correcting. It saves workhours.

A DBMS also has some disadvantages;

1. A DBMS environment is more complex for the personnel who must manage the system and data.
2. A DBMS is expensive.
3. Software purchase costs are high.
4. Usually more memory is required.

The database systems will not require any special type of hardware. Database processing, however, does involve special programs and overhead data. Thus database applications often require more main memory, a faster CPU, and more direct access storage. Figure 3.2 shows typical database processing.

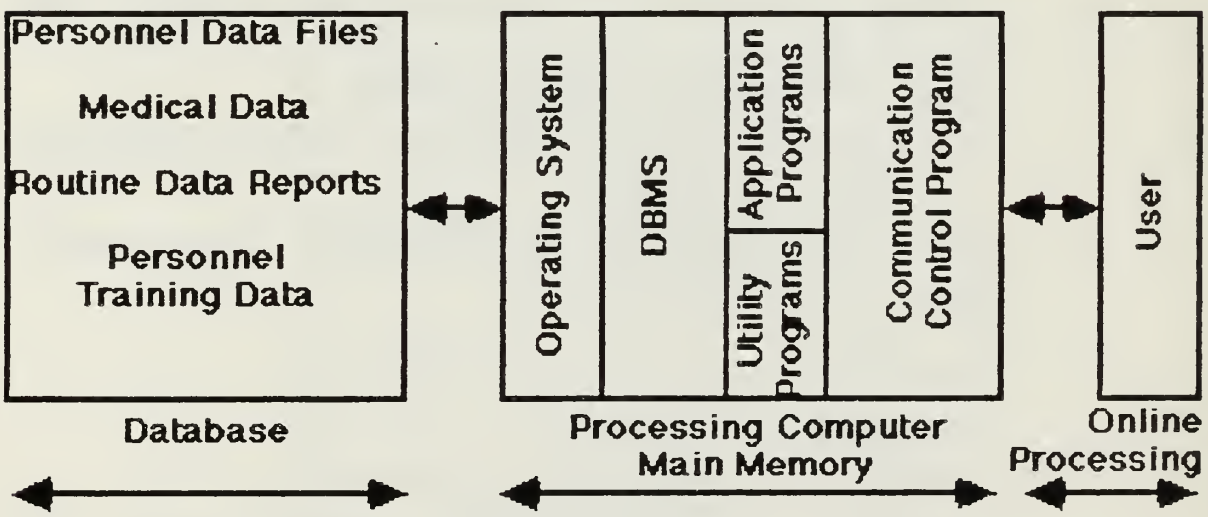

Figure 3.2 Typical Database Processing.

The requests are sent to the processing computer over communications lines. Then, the requests are received and routed by the communications control program (CCP). This

program has several important functions. It provides communications error checking and correction, it coordinates terminal activity, it routes messages to the correct next destination, and it formats messages for various types of terminal equipment.

The CCP routes online input to the next level of programs. This level contains application programs (AP) as well as database utilities. The application programs satisfy specific needs such as data entry or inventory control. The utility programs provide a wide variety of services. Query/update utilities provide generalized retrieval and update of the database.

DBMS acts as a sophisticated data librarian. The DBMS receives data and stores it for subsequent processing. Both the application and utility programs call on the DBMS to provide database service. The DBMS allows application programs and utilities a wide variety of access strategies.

B. DATABASE MODELS

Database models are used to categorize DBMS products. Also, Database models are an important database design tool for both logical and physical database design, such as flowcharts or pseudocodes are used for program design. Logical design is the process of transforming the system specifications into a human oriented database design. The term "human-oriented" means a design that has meaning to people rather than to computer systems. After a logical design has been specified and reviewed, the designers transform it into a physical design for implementation using a specific DBMS. The database is the bridge between people and hardware. The characteristic of both people and hardware need to be considered. There are two commercial database models: hierarchical, and network, and other six common database models. [Ref. 10].

1. Components of Database Model

The data manipulation language and the data definition language are two major components of database models. The Data Definition Language (DDL) is a vocabulary for defining the structure of the database. The DDL must include terms for defining records, fields, keys, and relationships. In addition, the DDL should provide a facility for expressing a variety of user views.

Data Manipulation Language (DML) is a vocabulary for describing the processing of the database. Facilities are needed to retrieve and change database data. Two types of Data Manipulation Language exist (procedural and non procedural). Procedural DML is a language for describing actions to be performed on the database. Procedural DML obtains a desired result by specifying operations to be performed. For procedural DML, facilities are needed to define the data to be operated on and to express the actions to be taken. Both data items and relationship can be accessed or modified. Also, to ensure that the database can be accurately recovered in the case of failure, commands are needed to define logical transactions, and to eliminate changes in case of a program-detected error. Nonprocedural DML is a language for describing the data that is wanted without describing how to obtain it.

2. Commercial Database Models

a. Hierarchical Data Models

A hierarchical data structure is referred to as a tree structure. A model is hierarchical, if its only data structure is a hierarchy (tree). A tree is a collection of records and one-to many relationship among records. The records are called nodes, and the relationships between records are called branches. In a tree-structure database, every node has only one node related to it at a higher

level. With the hierarchical model, all networks must first be decomposed to trees before they can be represented. Figure 3.3 shows a hierarchical model.

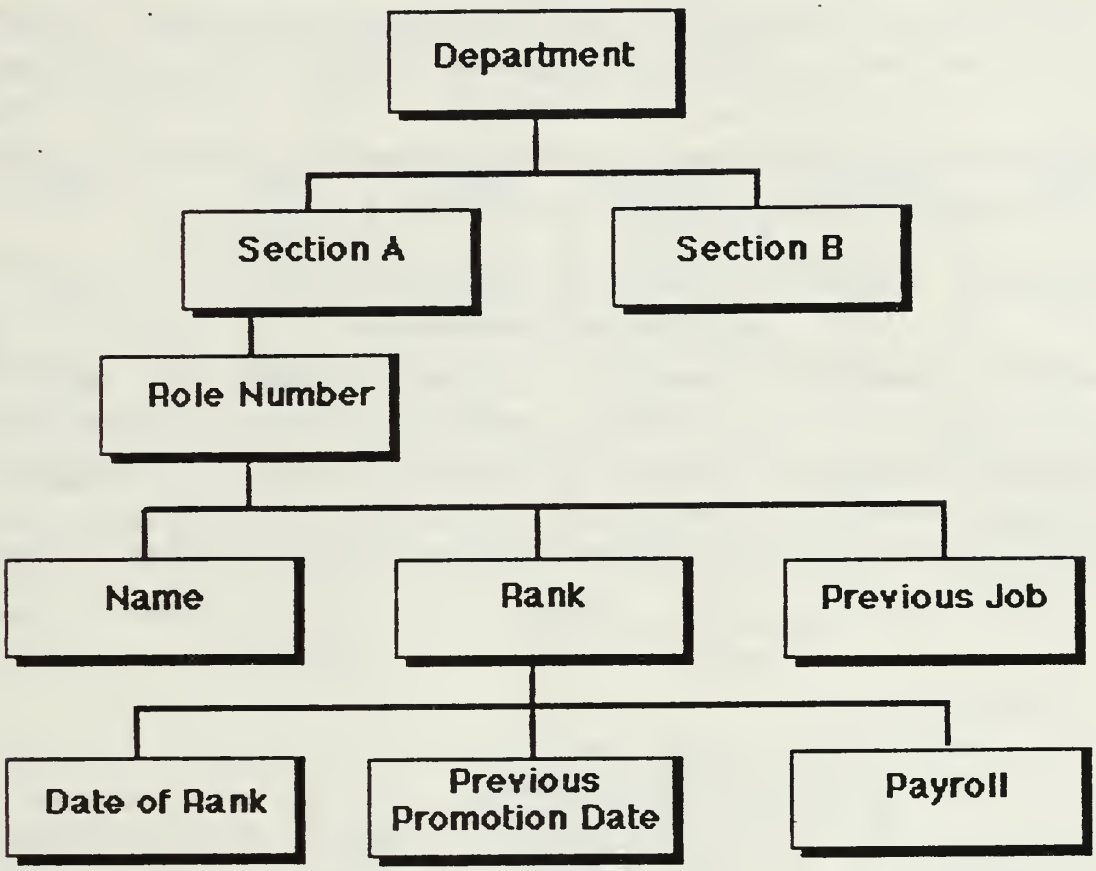

Figure 3.3 The Hierarchical Model.

b. Network Data Models

A network data structure occurs when each data item has more than one "parent" associated with it. Network structures allow any item to be linked to any other item. Complex networks need to be decomposed before they are represented.

3. Overview of Common Database Models

a. Semantic Data Model

The semantic data model provides a vocabulary for expressing the meaning as well as the structure of

database data. As such, SDM is useful for logical database design and documentation. SDM can be used to describe what the users want to see. The major advantage of SDM is that it provides a facility for expressing meaning about the data in the database. Another advantage of SDM is that it allows data to be described in context. Users see data from different perspectives. Another advantage of SDM is that constraints on the data can be defined.

b. The Entity-Relationship Model

The Entity-Relationship model (E-R Model) is explicit about relationships. In the E-R model both entities and relationships are considered to be different constructs. Entities are grouped into entity sets, and relationships are grouped into relationship sets. Entities are representations of objects in the real world. The E-R model can be used for logical database design. Also, entity-relationship diagrams can be used to express a physical design for relational implementations.

c. The Relational Model

The relational model is logical in that data is represented in a format familiar to humans. It is unconcerned with how the data is represented in computer files. On the other hand, the relational model is more physical than SDM or the E-R model. There are relational DBMS products. This means that databases designed according to the relational model need not be transformed into some other format before implementation. Thus the relational model can be used for both logical and physical database design. The relational model represents data in the simple form of tables. A relation is simply a two dimensional table that has several properties. First the entries in the table are single-valued; neither repeating groups nor arrays are allowed. Second, the entries in any column are all of the

same kind. For example, one column may contain crew name, while another contains ages. Each column has a unique name and the order of columns is immaterial. Finally, no two rows in the table are identical and the order of the rows is insignificant. Figure 3.4 shows these tables.

Name	Role Number	Rank	Depart-ment	Section	Duty
Name	Previous Job	Start Date	End-Date	Where	Language
Role Number	Name	Marital Status	Depend-ents	Address	Phone
Name	Rank	Birthday	Home Town	Blood Type	Planned Vacation

Figure 3.4 Relational Model.

The significance of the relational model is not that data is arranged in relations. The principal advantage of carrying relationships in data is flexibility. Relationships need not be predefined. More research has been done regarding the relational model than for any other model. [Ref. 10: p. 197].

d. CODASYL DBTG Model

The CODASYL DBTG (Conference on Data System Languages, Database Task Group) is a physical database model. There are constructs for defining physical characteristics of data, for describing where data should be located, for instructing the DBMS regarding what data structures to use for implementing record relationships, and other similar physical characteristics.

A DBTG schema is the collection of all records and relationships. A subschema is a subset and possibly a reordering of records and relationships in the schema.

Unlike the relational model, relationships become fixed when they are defined in the schema.

The DBTG model is a long way from user requirements. Therefore, it is difficult to use for logical database design. Rather, the logical database design should be expressed with a model like SDM and the logical design then transformed into a physical design using the DBTG model.

e. DBMS - Specific Models

The DBMS is considered a relational system if it conforms, in essence, to the relational data model. Alternatively, a DBMS is considered to be a CODASYL DBTG data model. A third category of DBMS is that if it does not conform to one of the above two data models, it has its own, unique data model. There are many systems that fall into this category; some of them are exceedingly successful. They simply have a unique design.

When one of the specific models is to be used, the designer can develop the logical database design using a model like SDM. Then, the logical is transformed into a physical design using the constructs of the available DBMS. There is so much variety among the other DBMS that it is difficult to make more speficic comments.

f. ANSI/X3/SPARC Data Model

The ANSI/X3/SPARC (American National Standards Institute/ Committee X3/ Standards Planning and Requirements (Sub)- Committee) data model does support the other data models. The X3 model is a model for DBMS design rather than for database design.

In these database models, Relational database will be used to develop an intelligent database. The relational DBMS is used to manage small to medium databases with moderate workloads and where the need for flexibility and rapid response to new requests is essential. Also, the

relational database management system supports independence better then other models and it's easier to implement.

C. AVAILABLE DATA BASE MANAGEMENT SYSTEM

A good DBMS should fill the gap between a custom-designed application program and an off-the -shelf general-purpose package. The DBMS's perform four functions : data input, selection and sorting, processing, and report output. The most useful DBMS systems for microcomputers are Power base, Salvo, DataFlex, Informix, dBASE 2, dBASE 3.

1. Power Base (Power-Base Systems, Inc.)

Power Base is an integrated, menu-driven, relational database management system designed for the end user, as opposed to systems with procedural languages, which are really intended for use by applications designers and programmers. It is special in that it gives the end user a great deal of almost effortless power via a menu-driven system. Documentation is excellent. This system's ease of use is excellent. Flexibility is limited by constraint of menu-driven format. Power Base strengths are on the input side. Its weaknesses are mostly on the output side. For example, Power Base's report writing facility allows only one sort level. The report-writing utility is basically not much more than a listing device. This system needs 230K RAM, 2 Disk drives. A hard disk is recommended.[Ref. 11].

2. Salvo (Software Automation, Inc.)

Salvo DBMS can be used both nonprogrammers and advanced practitioners. Salvo DBMS uses the relational model. It makes complete use of the flexibility of relational data management. It is easy to use, fast, and flexible. Its language is not a general-purpose and it would

not be a good replacement for a normal high-level language, for example, the way some people use dBASE 2's language. This system has three main methods of accessing and retrieving information : natural language requests, graphic views of data file relationships, and the SALVO programming language. Documentation is good. Flexibility and ease of use is excellent. This system needs 128K RAM, 2 disk drives. [Ref. 12].

3. DataFlex (Data Access Corp.)

DataFlex is a flexible, powerful, and complex applications development system. Its advantage is primarily in the broad spectrum of operating systems and machines it supports-both 8-and 16-bit machines and single and multiuser operating systems. Its major drawback is its complexity. DataFlex is a complex and powerful system designed to help applications programmers. A strong feature is DataFlex's ability to break screens down into images, called pages, that can be used to generate forms with or without data. DataFlex is very useful for a large company seeking to standardize database management on a variety of machines and operating systems. This system needs 100K RAM, 2 disk drives. [Ref. 13].

4. Informix (Relational Database Systems, Inc.)

This system is written in C language and was originally developed for the UNIX world. It is available on a large number of CPU's running UNIX, XENIX, and other similar operating systems and has been transported over to the PC. The Informix system's most serious deficiency is its lack of a procedural language of a caliber that matches the rest of the system. Also, Its major drawback is that it must produce a third temporary file. It is very easy to work with. This system needs 256K RAM, and a hard disk [Ref. 14].

5. dBASE 2 (Ashton-Tate Corp.)

This system does not have menus for the individual processing tasks. The program will load and be ready for operation in 2 or 3 seconds. One of dBASE 2's strongest points is its ability to access a data file rapidly and to find and display or print out single or groups of logically selected records with a minimum of operator direction. Simple application programs can be easily generated by the newcomer to computing. For more complex applications, the dBASE 2 programming language is flexible enough to accomplish almost any application. dBASE 2 has been criticized for its almost total correspondence to earlier 8-bit CP/M versions. Although compatibility and consistency are strong arguments for keeping 8-and-16 bit versions essentially identical, dBASE 2 does not take advantage of the power offered by the advanced operating system of a 16 bit machines. [Ref. 15].

6. dBASE 3 (Ashton-Tate Corp.)

dBASE 3 is one of the best selling programs on the market. It supports only 16 bit machines. dBASE 3 is written in C, so its portability is greatly enhanced. It can be used for UNIX, CP/M-86, CP/M-68K and other current and future operating systems and microprocessors. dBASE 3 is a major advance over dBASE 2 . It is faster in almost all respects, its language is more sophisticated and powerful, its help and assistance support is more useful. dBASE 3 has character, numeric,logical, date and memo fields. This system needs 256K RAM, 2 disk drivers or 1 drive and a hard disk [Ref. 15].

In these DBMS, DataFlex is very useful for multitasking systems. DataFlex has user password future. Also, It is very useful where working in an environment of mixed machines and operating systems.

IV. SYSTEM DESIGN CONSIDERATIONS

The environment on board a combatant ship is very different from a typical office on land. There are many limitations which must be considered during the installation of microcomputer systems on ships. These are:

1 Limited space
2 Power supply
3 Ship's Vibration
4 Surrounding workstation temperature, humidity, air-conditioning.
5 Miscellaneous environment requirements. [Ref. 16].

A. LIMITED SPACE

The RTN's surface combatant ships have doors that are 20-26 inches wide and 50-60 inches high. Openings of this size are restrictive. The system components must fit through these openings. Also, the RTN's combatant ship has limited available space for additional equipment. The smaller the physical size of the equipment, the more adaptable it is to shipboard use.

B. POWER SUPPLY

The RTN's combatant ships have an electrical system of 115 volt A.C and 60 Hz. This electric power is not regulated, and consequently, power fluctuations and total outages are experienced.

1. Power Fluctuations

Electrical fluctuations can cause microcomputers to lose bits of data and/or scramble stored data by picking up extraneous signals, thereby making records useless. A power regulator will monitor AC power and call up reserve power when needed. Microcomputers are connected to ship's power with the voltage surge suppression devices. Operation of the microcomputers without these devices can cause the malfunctions in the power suplies and, possibly, other problems.

The ZOG Technology was installed aboard the US Navy Aircraft carrier USS Carl Vinson (CVN 70) in late 1982. ZOG was implemented on a distributed network of 28 PERQ microcomputers connected through an Ethernet communication system. The malfunctioning power supplies were most likely caused by excessive surge of line voltage in the ZOG technology. After line voltage surge suppressers were installed in the ZOG Technology, The frequency of power supply malfunctions decreased.[Ref. 17].

2. Loss of Electrical Power

If a ship losses electrical power, Random Access Memory (RAM) losses its contents. Microcomputer systems need an Uninterruptable Power Supply (UPS). The microcomputer power cord can be plugged into the uninterruptable power supply and its power cord into the AC wall socket. If the AC drops voltage, the UPS powers the microcomputer by converting the DC energy stored in its internal battery into the AC power the microcomputer needs.

There are several types of UPS; all have a battery charger powered by the AC line, a battery and inverter circuits that converts DC into AC. Some UPS models, classified as "off_line" are usually called battery_backup systems. They maintain a full charge on their batteries if

the AC line voltage operates normally. However, when the AC voltage drops below a present threshold or trigger level, because of either an outage or a deep brownout, the off_line UPS automatically comes on line. The inverter circuit turns on, and the output sockets are switched, or transferred, from the AC line to the UPS inverter output. This UPS is not sufficient. If the outage occurs just as the disk drive motors are starting the DC voltages might drop out before the UPS completes its switchover. If that happens, the contents of the microcomputer's memory will disappear.

The "on_line" UPS must provide sufficient power and operate reliably. It differs from the off_line battery_backup type in that its inverter is always on and supplying power to the microcomputer's AC input. Because the computer is always drawing power from the backup battery, a power outage or brownout would have no effect on the immediate operation of the inverter or the computer connected to it. In the event of an outage the battery charger would stop charging the back_up battery. Since no switchover is required, no memory loss occurs [Ref. 18].

C. VIBRATION

Ships vibrate when they generate their electrical power, whether underway or in port. Vibration from the ship's engines affects the operation of the computer. Although vibration is not a problem for the user, its negative effect on the computer may certainly interfere with user/system operation. Ships can run into sudden shocks in the rough seas or during docking time. These sudden shocks can be dangerous to the microcomputers. The equipment should be mounted on shock absorbing mounts.

D. SURROUNDING WORKSTATION TEMPERATURE, AIR CONDITIONING, AND HUMIDITY

High operating temperatures can change the operating characteristic of semiconductor memory and other digital components of a computer system. High temperatures can bring about other effects that may be responsible for computer failure.

Electronic components have finite lifetimes, which to a great extent depend on the temperatures at which they are operated. Overheating decreases the MTTF (Mean Time To Failure).

The RTN's combatant ships workstation temperatures are between 60 to 90 degrees Fahrenheit. Most microcomputers can be operated within this range of temperature. Also, The RTN's combatant ships workstation humidity is between 15 to 85 percent without condensing. During cold weather, humidity is likely to be low, and it may be necessary to add moisture to the air. Smoky, greasy, and dusty weather can affect the microcomputer's circuits. Air conditioning equipment for workstations spaces and air filters for the system are necessary.

E. MISCELLANEOUS ENVIRONMENTAL REQUIREMENTS

The workstation environment must have sufficient work-space around terminal, low noise level, enough illumination,and suitable table height and chair adjustability.

Floor material in the workstation must be resistant to static-electricity buildup. Static electricity buildup is produced by the motion of people and furniture. It is desirable to maintain a relative humidity at 50% to prevent static electricity.

F. OTHER SYSTEMS NEEDS

1. Modem

The Republic of Turkish Navy is considering building a computer system at Golcuk. It would be necessary to communicate between the vessel's microcomputers and the main computer system at Golcuk. This communication can be conducted using modems.

A modem gives the computers the freedom to communicate with other computers and to access databases. A modem transfers digital information from one microcomputer/computer to another computer. It converts digital computer data into audible analog signals, so that data may be sent over a telephone line. The tones are then converted back into computer data by another modem at the destination. Modems come in many different shapes and sizes, with a wide range of prices. Today's modems can sent and receive up to 10,000 bytes per second.[Ref. 19].

2. Communication Software

Communication software allow computers to share data. It controls the rate of information transfer, screen display and storage.

Some communication software offers special features such as automatic log-on; uploading and downloading of files. A few computers have communications software built into their read-only memory.

3. System Security

When microcomputers are installed on RTN combatant ships, the RTN probably will run into security problems. System security includes preventing unauthorized relase of information, unauthorized modification or destruction of data, and unauthorized copying/discovery of data. First of all, a system security officer must be chosen for each ship.

The system security officer should be responsible for 1) proper verification of soldiers security clearances and information-access authorizations; 2) determination of operational system security status; 3) surveillance and maintenance of system security; 4) changing of security passwords for software packages.

There are also physical and data security problems. Physical security deals with protecting external elements of the computer system. There are specialized locking devices that prevent external access to circuit boards, or block access to the on/off power switch. Also, there are fireproof safes and locking cabinets for storing floppy diskettes. The RTN may have these kind physical security devices.

Data security deals with protecting the internal elements of the computer system. A password is a data security device for maintaining privacyion the RTN microcomputer system. The user must enter the appropriate password in order to gain access to the data for which they have been cleared. Passwords can be letters and/or codes, usually four or more characters, that identify individuals. Access is granted to ship members who enter the correct code to a software package. Also, these passwords can be used in hierarchy to provide entry to different layers of information in a corporate data base. All passwords must be changed at least monthly, or whenever the user suspects it has been discovered. These passwords must be changed by the system security officer.

4. Training Center

The RTN combatant ship's crew generaly are not very familiar with microcomputers. They must be trained on land. The RTN must have a microcomputer resource center at Golcuk or another place. This center could consist of a standard system with printer and application software for use. This center would provide assistance to RTN users of microcomputers in the following areas:

1 Introduction to computers and use.

2 Start-up procedures.

3 Utilities.

4 Demonstrations.

5 System security and maintenance.

6 Application software use.

7 Data base management software use.

5. Technical Manuals

The RTN must have technical manuals covering the system's hardware and software components. Also, this technical manuals must be converted to Turkish Language. The following manuals must be provided by the vendor:

1 User's Manuals.

2 Operating System Reference Manuals.

3 System Reference Manuals.

4 Programming Language Manuals.

5 Utility Manuals.

6 Maintenance Manuals for hardware components.

A short description for each type of manual follows:

1 Users' Manuals : Users' manuals must contain information pertaining to available system capabilities and the information required to use the system in order to respond to system-generated messages.

2 Operating System Reference Manuals: Operating system manuals must contain a description of the operating system capabilities and programmer-controllable functions.

3 System Reference Manuals: System reference manuals must provide information to user personnel detailing the system configuration.

4 Utility manuals: These manuals must describe the capabilities of the utility programs.

5 Programming Language Manuals: Programming Language manuals must be suplied for BASIC, and COBOL. The manuals must be written for programmer level personnel.

6 Maintenance manuals: Maintenance manuals must provide information required for user and maintenance personnel to perform corrective maintenance.

V. EVALUATION METHOD

Buying a microcomputer is a complex decision. As microcomputers become more and more popular, their choice becomes increasingly difficult and complex. There are currently more than seven hundred models available in the market [Ref. 20]. At first sight they all look 'similar'. But in fact, they differ in price, memory size, expandability, color and graphic capability, sound, etc. More importantly, none of these microcomputers clearly outranks one of the others in terms of the characteristics mentioned above. Each of them has some unique feature but also lacks some nice performance that the others have. This makes the decision difficult.

One solution to this complex decision is to use an evaluation technique. A simple approach is to list computers that are available and compare them on the basis of features and cost. The weighted or multiplication factor for each feature, relating its importance to the RTN's needs will be used in this evaluation.

Every evaluation criteria should have its own evaluation weight between 000 and 100. Also, every evaluation criteria has its own features. Same feature will be compared for all systems at the same time, for example, microprocessor speed. Then, that feature will be relatively rated for all system between 0.00 and 1.00. A 1.00 will be given to the system that has the best feature. If an evaluation criteria has more than one feature, the average of its features will be calculated. This average will be multiplied with the evaluation criteria weight to get an evaluation factor for that criteria. Then the evaluation criteria factors will be added to get a system total score.

The five highest scoring systems should then be leased for a six month on-board evaluation period to develop true MTBF, ease of use, and discountable cost data under actual conditions. The results of this test will then be used to recommend a standard system for the RTN. The most cost/effectiveness system will be chosen. If two or more system have same cost/effectiveness ratio, then one of them will be chosen which has the best announced future applications.

Evaluation criterias and the evaluation criteria's weights are :

1- Reliability (100)
   a) Company
   b) Reliability factor(MTBF)
2- Maintenance support (90)
   a) Warranty limit
   b) Service support
3- Hardware (85)
   a) Microprocesor speed
   b) Keyboard
   c) Mass Storage
   d) Monitor
4- System compatibility (80)
   a) Interface
   b) Operating system
5- System expandability (75)
   a) Max RAM
   b) Expansion slots
6- Software availability (70)
   a) Language
7- Physical features (60)
   a) physical size

A. RELIABILITY

A ship is an independent unit when it is underway. It can not stop to get manufacturer's support when its microcomputers fail. For this reason, reliability is the most important evaluation criteria when selecting a microcomputer system for RTN.

There are some measures related to equipment failures. Mean time between failures (MTBF) and mean time to repair (MTTR) are both measures of equipment reliability [Ref. 22]. MTBF formula is:

$$Ri=Hi/Ht \qquad \text{(eqn 5.1)}$$

Where Ri=Component i reliability factor, Hi= Number of hours component i inoperative, Ht= Number of hours in evaluation period.

For all practical purposes, microcomputers are highly reliable in a "normal" environment after they have worked correctly for the first 200 hours. This test-period is called the 'burn-in' phase; most malfunctions will occur during this time. The probability of failure after this period is much smaller. A "normal" environment means that there are no extreme variations of temperature or humidity.

It is important that replacement parts are available in years to come. The company should be actively developing new products and be able to offer a variety of components and systems to meet all the RTN combatant ship's needs. The financial situation of the company, size, and availability of products, should all reflect the company's reliability.

B. MAINTENANCE SUPPORT

Microcomputer systems can be tested by the manufacturer when manufactured. Some components (Printer, disk drive, hard disk drive, etc.) may appear to work for a few hours, then hardware, software problems occur.

Republic of Turkish Navy should get a hardware and software warranty covering at least 6 months. Also, RTN should get a good program of preventive maintenance. Vendor's service personnel can service the system periodically, for instance, once every 6 months.

Training packages are important for RTN. RTN must receive operator training, and the system maintenance packages from the dealer. The location of vendor is important for receiving good service.

C. HARDWARE

The physical parts of a computer system are the CPU, keyboard, printer, monitor, and disk drive.

1. Microprocessor and Speed

The main component of the microcomputer is the microprocessor. The relatively fast development of microprocessor that perform a greater number of full computer functions, and capable of doing more things in a shorter period of time. The most popular 8-bit microprocessors are Intel 8080, MOS technology 6502, Zilog Z80, and Motorola 6800 series. The Intel 80186, 80286 and Motorola (16-/32 bit MC68000 series) are videly used at multiuser environments [Ref. 23].

As the popularity has gone from 4-to 8-to 16-to 32-bit microprocessors. The data word size is the number of bits that can be stored or retrieved (input/output) from memory at one time. The wider the data word, the more information is processed and therefore processing speed is effectively increased. Also, Longer word lengths permit greater precision, addressability of more memory, and better performance.

2. Keyboard

Generally, the keyboard is similar to that of a typewriter. The keyboard can be a part of the monitor or separate. A separate keyboard can easily be placed in the most comfortable position for a given user.

The keyboard's appeal is enhanced by a variety of items, such as the spacing between keys; number of special keys; the angle, shape and surface texture of the keys; pressure and distance required to operate the keys; tactile or auditory feedback on reaching bottom; and clarity of the characters on the keys. Additionally, the placement of special keys is an important consideration. If the "Reset" key (used to return the computer to a start-up condition, thereby clearing all nonpermanent memory values) is close to the "Return" key (frequently used by operators to indicate the completion of data input), the result could be disastrous.

Some input terminals contain a microprocessor. If so, they are called smart or intelligent. The advantage of an intelligent terminal is that it lessens the communication between the terminal and the processing computer, as well as reducing the computer's workload. The disadvantage is that smart terminals are more expensive.

The keyboard's key roller protection feature is important. A problem occurs when several keys are depressed simultaneously, or almost simultaneously. This can occur, for example, during rapid data entry. Simple keyboards may ignore, refuse or discard the additional key pressed. A "protected" keyboard will automatically store multiple-key closures, as long as they are not simultaneous. Ten-key numeric pad is important feature for keyboard.

3. Printer

Major considerations for choosing a printer are cost, speed, noise, and quality of output.

There are currently hundreds of different brands and models of printers, They can be classified in three ways, according to their mode of operation [Ref. 1].

a. Serial vs Line Printers

Serial printers print one character at a time. They are similar to a typewriter. Serial printers operate at speeds of 50 to 400 characters per second. Some serial printers can print in both directions so that time is not wasted on carriage returns.

Line printers print a full line at a time. Line printers operate at 300 to 6000 lines per minute. Line printers are generaly more expensive and require more space. Minicomputer and mainframe computer printers are line printers, using chains, bands, drums and cylinders to print full lines of characters at a time, which is not feasible for microcomputer output.

b. Impact vs Nonimpact

Impact printers create characters by striking the paper through a ribbon. They can print characters and graphics at a variety of speeds, styles and qualities. Impact printers are noisy, but noise level can be shielded. Impact printers can make several copies at a time. Non-impact printers use dot patterns to produce images, but never impact the paper. Non-impact printers are quiet, and some are much faster than impact printers. Non-impact printers can not make more than one copy at a time. Non-impact printers use ink jets, laser and thermal or electrosensitive reactions to place images on paper. Non-impact printers are fast, quiet, nonmechanical and expensive.

c. Dot-Matrix vs Full-Character (Daisy-Wheel)

Full-character printers print a whole character in the same way that a typewriter does. They are reliable in operation with superb print quality, But they are expensive, and complicated. Dot-Matrix printers use pins to print a pattern of dots on paper. Naturally, the more dots in the print head matrix, the more defined the characters will be. The general advantage of a matrix printer are; relatively

low cost and high speed. The main disadvantage in the relatively poor quality is that is sufficient for the eye, but not for reproduction. Recent advances in dot matrix technology, however, are improving the type quality to the point where it almost matches a daisy wheel printer. Impact serial dot-matrix and fully format character printers are the mainstay of the microcomputer printer industry.

Impact serial dot-matrix printers are useful and economic to RTN needs. They are relatively low cost, and high speed. Also, They have multiple copies feature and can mix bold, italics, foreign language characters on a single line.

4. Mass Storage

The memory inside a microcomputer is limited and volatile, large programs and files must be stored on a permanent medium. The permanent storage devices are 8-inch Floppy disk, 5 1/4 -inch Minifloppy disk, 3 1/2 -inch microfloppy disk, Winchester hard disk, and Electronic disk. The floppy disk is a flexible mylar disc that is coated on both sides with a magnetic oxide material. Floppy diskettes must be protected from stray magnetic fields that are prevalent near some ship's machinery. Floppy diskettes have a small storage capacity of generally less than 1 MB.

The Winchester disks storage capacity is dramatically higher than floppies. The minimum capacity is around 5 million bytes, and some can hold as much as 700 million bytes. Winchester disk drives are quiet, fairly reliable, reasonably light, and extremely fast.

The storage capacity 40 Millions bytes hard disk, and one or two high capacity disk drives are requirement for RTN.

5. Monitor

Most computer monitors display at least 24 lines of 80 characters each. This size gives the designer good

flexibility in permitting the operator to view a large amount of data and interactions while still leaving room for prompting and error messages.

The character size is determined by the number of dots in the matrix that forms the character on the screen. Five dots across by seven dots up and down had been standard. Some vendors now use a 6-by-7 or 7-by-9 dot formation because the more dots per character sell, the sharper and clearer the character appears.

There are two types of monitors: monochrome and color. Monochrome (single-color) monitors usually display their characters as white, green or amber. Generaly, A green or amber display is easier to work with for long periods of time than a simple black-and-white monitor.

A color monitor is more expensive than a monochrome monitor, but it will display several colors simultaneously. A monochrome monitor is sufficient for RTN needs.

D. SYSTEM COMPATIBILITY

1. Interface

Most microcomputers today provide an internal connection through a standard data "bus". The most popular one is the S-100 (IEEE 696). If simplicity and convenience in connecting additional devices are required, the S-100 bus has a definite advantage because it is by far the most widely available.

The Teletype 20mA current loop, The standard RS-232C serial interface, and a parallel printer interface (IEEE-488 or Centronics) are useful in the back of the mainboard for simplicity and convenience in connecting additional devices.

2. Operating System

The Disk Operating System (DOS) is a collection of programs that provides the interface to interpret command input and manipulate data files on the disk.

Application programs need a special operating system, in order for the applications program to work. Because, application programs can be written to 'run under' an operating system, the microcomputer system must be compatible with the more common operating system. The most common operating system is MS-DOS. Microsoft corporation developed PC-DOS for IBM, and MS-DOS for compatibles. MS-DOS takes advantage of the large number of available software programs [Ref. 21]. MS-DOS is the most frequently used system for 16- bit computers. The second most common operating system for 8-bit microcomputers is called CP/M (Control Program/Monitor). There is also a 16-bit version of CP/M called CP/M-86. New CP/M plus is a powerful option for an advanced user to have due to its flexibility and features, as well as its almost complete functional compatibility with the CP/M family of software.

Several operating systems permit multiple users to share a single computer. Multi-Processing Monitor Control Program (MP/M), MS-DOS, or UNIX allow several users to run different programs concurrently on one computer. UNIX is transportable, it can run on many different brands of computers. UNIX takes advantage of the special and advanced features of the 16-bit and newer 32-bit processors. There are many versions of UNIX. Some of the licensed versions of UNIX already available are XENIX for Apple' Lisa, VENIX for the DEC Professional 350, VENIX and XENIX for the IBM PC, TRS XENIX for the TRS-80 Model 16, UniFLEX, and UNOS.

E. SYSTEM EXPANDABILITY

1. Max RAM

Two types of electronic memory exist in all computers: random access memory (RAM) and read only memory (ROM). RAM is a memory that can be both read and written. RAM must be used in a system for data, otherwise it would not be possible for the microprocessor unit to store the

results of its computations or the data it might be reading from the keyboard or another input device. The size of a program, or file, which users wish to load in a microcomputer system is limited by the amount of RAM the system has. Envisioned uses indicates that at least 512K RAM capability systems are necessary for RTN combatant ships.

2. Expansion Cards

Expansion cards allows future expansion to the computer and the addition of capabilities that did not exist when the machine was designed. Expansion slots are sockets inside the computer that can accept specially designed circuit boards. Expansion slots can accept and use any circuit board that conforms to their specifications. This includes boards that provide many different capabilities.

When expansion cards are added they tend to restrict the airflow within the computer. The larger card will contain the more heat-producing components. In such a situation, it will be important to have a larger fan or even air conditioning for the system.

F. SOFTWARE AVAILABILITY

1. Language

There are two kinds of software resources for microcomputers: 1) software that is provided by the microcomputer manufacturers to enable the user to develop his own applications programs and 2) The application programs themselves.

A manufacturer's software should include, as a minimum, a good macro assembler, a resident high-level language compiler, a disc-operating system, a system supervisor and a program (and hardware) for in-circuit emulation. It is desirable that the output from the assembler and the compiler be compatible so one can link and relocate programs supplied by various manufacturers. It is useful to be able to link into current programs, such as routines and subprograms which are stored in a library file on disc to save

repetitive typing. Another extremely useful program which should be available from the manufacturer would be an efficient real-time executive, as this can significantly reduce software preparation time. As far as applications programs are concerned, the software supplied by the manufacturer should allow and encourage the user to write his programs in a modular fashion.

Languages are created to serve specific or general purposes. Special purpose languages include C, Forth, Modula-2, Smalltalk, and Prolog. General purpose languages are extremely flexible, and their ultimate use may far exceed the original plans of their designers. General purpose languages include BASIC, FORTRAN, COBOL, LISP (List Processing), LOGO, ALGOL, Pascal, APL and PL/1. The majority of programming applications have been written in BASIC, FORTRAN, or COBOL.

COBOL (Common Business Oriented Language): COBOL is characterized by programs stated in precise, easily learned natural words and phrases that can be read by nontechnical users. Cobol is a highly specialized language. Cobol is the most widely used language on larger computers but is not yet used significantly on microcomputers.

FORTRAN (Formula Translation): Fortran was initially developed for solving problems in mathematics, engineering, and science. FORTRAN treats arithmetic operations with commands that evaluate expressions and substitute the results for current values of variables. Character string manipulation in FORTRAN is difficult but not impossible.

BASIC (Beginners All-Purpose Symbolic Instruction Code): Basic is currently the most widely used language on small computers. It incorporas features of both FORTRAN and ALGOL, this language was designed to be very simple to learn and inexpensive to implement and use.

Pascal : Pascal evolved from the ALGOL language which was utilized primarily in education and research. Pascal is a powerful and complex language that can be executed very quickly.

BASIC and COBOL language are recommended to RTN combatant ship's microcomputer system, Because they are widely taught in Turkey.

2. Word Processing

A word processing program is a text editing tool. Word processing is most useful for writing tasks which require frequent or extensive changes either during the creation of the original drafts or after that draft has been produced. Words, sentences, and paragraphs can be changed, deleted, substituted, or rearranged all in a matter of seconds by the word processor program [Ref. 24].

Word processing is the largest single application for the majority of microcomputers in use today. Word processing will be very important application for the RTN.

Every word-processing program has a different set of features. Some features are going to be important to RTN combatant ship's needs. These are ;

1 Easy use and learning

2 Good documentation

3 On-line help facility

4 Ability to be reliably copied for backup purposes

5 Ability to move the cursor easily and rapidly within a file

6 Ability to insert, delete, and move characters, words, phrases, lines, paragraphs, and pages within the document easily

7 Ability to search for and replace a character, word or phrase-either selectively or globally throughout the entire document

8 The ability to create page headers and page footers

9 The ability to make automatic page numbering

10 The ability to display file length in characters, words, lines, paragraphs, and/or pages.

G. PHYSICAL REQUIREMENTS

The working conditions aboard a RTN combatant ship was explained in the previous chapter. The chosen microcomputer system's size, temperature, and humidity tolerances must all fit the ships environment.

Also, Microcomputer's power supply must be large to allow additional expansion. Expansion boards usually get their electrical power from the computer's power supply. Each additional expansion board will have a specified power requirements, and the sum of these power requirements must never be more than computer's power supply rated output.

H. AVAILABLE SYSTEMS

Letters were written to twenty U.S. computer manufacturer asking for information about their products. Only six companies responded. They were Altos Computer Systems, Cromemco Inc., Computer Data Systems, Inc., Commodore Inc., Texas Instruments Incorporated, Wang Laboratories. Unfortunately, only three of the six respondes provided useful information. They were Cromemco Inc., TI, and Wang Laboratories. In addition to these three companies, another seventeen companies's products were chosen from [Refs. 25,26]. These twenty companies have multiuser systems and are worldwide companies. 16-bit multiuser systems were chosen for evaluation because multi-user systems have lower per-user cost and greater efficiency than stand-alone systems [Ref. 27].

The following pages list some example of evaluation criteria and the values that have been assigned. Appendix A shows these values in a a summary form.

1. Example

Every system features will be rated relatively. The speed of microprocessor is a feature of hardware criteria.

Microprocessore speed and theirs relatively rating are:

Company and Product		Mic. Speed	Rate
AT&T	Unix PC	10 Mhz.	0.90
Altos	486	8 Mhz.	0.75
Burroughs	B 25	8 Mhz.	0.75
CADO	ATS 8	8 Mhz.	0.75
Cromemco	CS-100	10 Mhz.	0.90
Esprit	DBS 16	8 Mhz.	0.75
Esprit	X -16	8 Mhz.	0.75
G.Automation	Z-1750	10 Mhz.	0.90
G.Robotics	Gemini	15 Mhz.	1.00
IBM	AT	6 Mhz.	0.60
IVY	DT-20	10 Mhz.	0.90
Micro Five	1050 E	8 Mhz.	0.75
Molecular	16/200	8 Mhz.	0.75
Monroe System	2000	8 Mhz.	0.75
North Star	Dimension	8 Mhz.	0.75
Perkin Elmer	7350 A	8 Mhz.	0.75
Sperry	10,20,30	7.2 Mhz.	0.70
Sperry	40,45,50	7.2 Mhz.	0.70
Stride	420	12 Mhz.	0.95
Stride	440	12 Mhz.	0.95
Texas	Business-Pro	6 Mhz.	0.60
Wang Lab.	APC	8 Mhz.	0.75
Zenith	Z-200 Advanced PC	6 Mhz.	0.60

The General Robotic's system 'Gemini' has the fastest microcomputer speed which is 15 Mhz. It is therefore given the highest system value of 1.00 point. The IBM system AT, Texas's system professional, and Zenith's Z-200 PC AT have the lowest microprocessor speed of 6 Mhz. It is given the lowest value of 0.60 point.

The Mass storage is a feature of hardware criteria. The mass storage and relative ratings are :

Company and Product		Mass Storage	Rate
AT&T	Unix PC	320K	0.70
Altos	486	1 MB.	0.95
Burroughs	B 25	630K	0.85
CADO	ATS 8	1.2 MB.	1.00
Cromemco	CS-100	390K	0.70
Esprit	DBS 16	780K	0.85
Esprit	X-16	780K	0.85
G.Automation	Z-1750	N/A	
G.Robotics	Gemini	1 MB.	0.95
IBM	AT	1.2 MB.	1.00
IVY	DT-20	360K	0.70
Micro Five	1050 E	655K	0.85
Molecular	16/200	512K-1200K	0.95
Monroe System	2000	720K	0.85
North Star	Dimension	360K	0.70
Perkin Elmer	7350 A	320K	0.70
Sperry	10,20,30	320K-360K	0.70
Sperry	40,45,50	320K-360K	0.70
Stride	420	640K	0.85
Stride	440	640K	0.85
Texas	Business-Pro	360K-1.2 MB.	0.95
Wang Lab.	APC	360K-1.2 MB.	0.95
Zenith	Z-200 Advanced PC	1.2 MB.	1.00

The Zenith's system Z-200 PC AT, and IBM's System AT has the largest disk capacity per drive. It is given 1.00 point. System Unix PC has the smallest disc capacity per drive. It is given 0.65 point.

The main memory 'RAM' capacity is a feature of system expandability. The Random Access Memory (RAM) expandable capacity and the the relative ratings are:

Company and Product		RAM Capacity	Rate
AT&T	Unix PC	512K to 2 MB.	0.75
Altos	486	512K to 896K	0.70
Burroughs	B 25	256K to 1 MB.	0.70
CADO	ATS 8	256K to 512K	0.65
Cromemco	CS-100	1 MB.to 4 MB.	0.85
Esprit	DBS 16	256K-3.58 MB.	0.85
Esprit	X -16	512K to 1 MB.	0.70
G.Automation	Z-1750	128K to 1 MB.	0.70
G.Robotics	Gemini	256K to 4 MB.	0.85
IBM	AT	512K to 3 MB.	0.80
IVY	DT-20	640K to 3 MB.	0.80
Micro Five	1050 E	28K to 512K	0.65
Molecular	16/200	512K-1.2 MB.	0.75
Monroe System	2000	128K to 896K	0.70
North Star	Dimension	256K to 512K	0.65
Perkin Elmer	7350 A	1 MB. to 3 MB.	0.80
Sperry	10,20,30	128K to 640K	0.65
Sperry	40,45,50	128K to 640K	0.65
Stride	420	256K to 2 MB.	0.75
Stride	440	256K to 8 MB.	0.90
Texas	Business-Pro	512K to 15 MB.	0.95
Wang Lab.	APC	128K to 768K	0.70
Zenith	Z-200 Adv. PC	512K to 16 MB.	1.00

The Zenith System Z-200 PC AT has the most expandable RAM which is between 512K to 16 MB. It is given 1.00 point.

The amount of expansion slots and their relatively rating are:

Company and Product		Expansion Sl.	Rate
AT&T	Unix PC	8	0.85
Altos	486	1	0.50
Burroughs	B 25	8	0.85
CADO	ATS 8	1	0.50
Cromemco	CS-100	8	0.85
Esprit	DBS 16	6	0.75
Esprit	X -16	6	0.75
G.Automation	Z-1750	5	0.70
G.Robotics	Gemini	7	0.80
IBM	AT	8	0.85
IVY	DT-20	3	0.65
Micro Five	1050 E	2	0.60
Molecular	16/200	10	0.90
Monroe System	2000	5	0.70
North Star	Dimension	13	1.00
Perkin Elmer	7350 A	2 1/2	0.60
Sperry	10,20,30	4 to 5	0.70
Sperry	40,45,50	3 to 4	0.65
Stride	420	1	0.50
Stride	440	1	0.50
Texas	Business-Pro	14	1.00
Wang Lab.	APC	8	0.85
Zenith	Z-200 Advanced PC	6	0.75

The Texas's system professional and North Star's system Dimension have 14 - 13 expansion slots. It is given 1.00 point.

The number of workstations for each system and their relative ratings are:

Company and Product		Workstations	Rate
AT&T	Unix PC	up to 3 users	0.60
Altos	486	up to 4 users	0.65
Burroughs	B 25	up to 32 users	1.00
CADO	ATS 8	up to 16 users	0.95
Cromemco	CS-100	up to 8 users	0.80
Esprit	DBS 16	up to 28 users	1.00
Esprit	X -16	up to 8 users	0.80
G.Automation	Z-1750	up to 12 users	0.90
G.Robotics	Gemini	4 to 16 users	0.95
IBM	AT	up to 4 users	0.65
IVY	DT-20	up to 3 users	0.60
Micro Five	1050 E	up to 12 users	0.90
Molecular	16/200	2 to 10 users	0.85
Monroe System	2000	up to 4 users	0.65
North Star	Dimension	12 to 62 users	1.00
Perkin Elmer	7350 A	up to 5 users	0.70
Sperry	10,20,30	up to 4 users	0.65
Sperry	40,45,50	up to 4 users	0.65
Stride	420	up to 4 users	0.65
Stride	440	up to 16 users	0.95
Texas	Business-Pro	up to 50 users	1.00
Wang Lab.	APC	up to 4 users	0.65
Zenith	Z-200 Adv. PC	up to 3 users	0.60

The North Star system 'Dimension' can have up to 62 workstations. It is given 1.00 point.

The warranty limits and their relative ratings are:

Company and Product		Warranty	Rate
AT&T	Unix PC	90-day	0.60
Altos	486	90-day	0.60
Burroughs	B 25	90-day part&labor	0.70
CADO	ATS 8	N/A	
Cromemco	CS-100	90-day	0.60
Esprit	DBS 16	90-day	0.60
Esprit	X -16	90-day	0.60
G.Automation	Z-1750	90-day part&labor	0.70
G.Robotics	Gemini	1 year	0.95
IBM	AT	1 year	0.95
IVY	DT-20	90-day	0.60
Micro Five	1050 E	120-day	0.75
Molecular	16/200	90-day	0.60
Monroe System	2000	N/A	
North Star	Dimension	90-day opt. 5-years	0.90
Perkin Elmer	7350 A	90-day	0.60
Sperry	10,20,30	90-day	0.60
Sperry	40,45,50	90-day	0.60
Stride	420	90-day opt.3-years	0.90
Stride	440	90-day opt.3-years	0.90
Texas	Business-Pro	1 year ext.5-years	1.00
Wang Lab.	APC	90-day	0.60
Zenith	Z-200 Adv. PC	90-day part&labor	0.70

The IBM's AT, General Robotic's 'Gemini', and Texas's Professional have one year warranties. But TI has a 5 year extension option. It is given 1.00 point.

VI. CONCLUSION

A. SUMMARY OF DECISION RESULTS

Five systems were chosen according to the stated evaluation criteria for final testing in the real environment. These systems can be leased for a specified period. The systems and their total scores are:

COMPANY	SYSTEM	SCORE
1. Texas Instrument, Inc.	Business Pro	501 Points
2. Inter. Business Machines Corp.	AT	497 Points
3. Burroughs Corporation	B 25	475 Points
4. Wang Laboratories Inc.	APC	466 Points
5. Zenith Data System Corp.	Z-200 Adv. PC	464 Points

TEXAS BUSINESS _ PRO

The Texas Instruments Business-Pro computer provides maximum flexibility in system configuration, and it offers a wide range of hardware options. It has 14 expansion slots of which 8 are full-size and 6 are half size expansion slots. The system can support up to 50 users in a Local Area Network. It can execute a rapidly expanding base of applications software with file and record locking capabilities. The Random Access Memory (RAM) can be expanded from 512K to 15 MB. Mass storage options include 360K byte 1.2 M byte floppies, 40, and 72 M byte winchesters. Several languages are available including MS-Basic, MS-Fortran, MS-Pascal, MS-Cobol, RM/Cobol, LISP, and C. The Texas with IBM - AT. The PC AT compatibility option allows much of the software

available for the PC AT to run on the Business-Pro computer. The system runs under MS-DOS 3.0, and Xenix V. System input and output includes standard parallel and serial ports. There is a full one-year warranty which optionally may be extended up to total five years.

IBM AT

IBM provides good service, large amount of software application packages, and a 1 year warranty (including specified individually at less than 1-year). The IBM AT runs under PC-DOS 3.0, PC-DOS 3.1, Xenix, and BIOS operating systems. The AT disk drive capacity is 1.2 MB. The RAM can be internally expanded from 512K to 3MB. IBM PC Macro Assembler, Basic, Cobol, APL, Fortran, and Pascal languages are available. The IBM AT has a parallel and serial interface. The system includes 8 slots for system expansion. Six of the slots support either 8-or 16-bit option cards, and 2 support 8-bit cards only.

BURROUGHS B 25

The Burroughs B 25 has 256K bytes of memory which can be expanded up to 1 MB. It has a dual diskette storage module with 630K bytes capacity. The modular system can support from 1 to 32 users using the XE520 shared resource processor. The XE520 workstation clusters utilize multiple dedicated high-performance processors to provide file handling as well as input/output management. The B 25 has serial and parallel ports (Two RS-232-C, one RS-449/442 and one Centronics Interface). The system runs under the BTOS, MS-DOS, and CP/M-86 operating systems. Programming Languages

are Basic, Cobol, Fortran and Pascal. The system has a 90-day parts and Labor warranty.

WANG ADVANCED PROFESSIONAL COMPUTER

The Advanced Professional Computer (APC) offers 360K bytes, or 1.2 M bytes half-height floppy diskette drives in addition to 20,30,or 67 M bytes fixed disk options. The APC supports two operating systems which are the industry standard MS-DOS operating system, and Xenix, a multiuser multitasking operating system. MS-Basic, MS-Cobol, MS-Fortran, and Pascal languages are available. There are 8 expansion slots. The system has a 90-day warranty. There are one RS-232-C and one Centronics interface. The U.S Karl Vincent is using Wang mini and microcomputers. Wang has support service available in Turkey [Ref. 28]. Rental contracts are available as well as quantity discounts, starting at 5 percent for 20 to 49 units.

ZENITH Z-200 ADVANCED PC

The Z-200 Advanced PC is IBM AT compatible. The Zenith Z-200 is equipped with 512KB to 16 MB. of RAM, a single 1.2 MB diskette drive, and six AT-compatible expansion slots. There are parallel and serial ports (one RS-232-C, and one Centronics type). It uses the MS-DOS 3.1 operating system. The Zenith Z-200 Advanced PC is capable of running most of the software designed for the IBM AT. Basic, Fortran, and Cobol languages are available. The system has a 90-day parts and labor warranty.

B. CONCLUSION AND RECOMMENDATION

The following conclusions may be drawn from this thesis:

1. Shipboard use of microcomputers showed as much as 50% savings of administrative workhours aboard U.S. Navy ships. Productivity improvements should be possible for all shipboard departments that use microcomputer aboard RTN combatant ships.

2. A properly implemented computerized DBMS should further increase productivity gains.

3. Shipboard computers must be rugged enough to withstand power fluctuations, vibrations, high humidity, and salt air.

4. Users must be aware of the need for increased data processing and physical security for shipboard computers.

5. Buying a microcomputer is a complex decision. It requires a formal decision process to narrow down the available choices. Reliability is the most important evaluation criteria for RTN combatant ships.

6. The RTN should establish a formal microcomputer evaluation team for final evaluation. The evaluation team must also consider other country's vendors that may be locally available by the time that the evaluation team is established.

7. Final evaluation and system selection should be accomplished after six month shipboard trial period between the five highest scoring systems outlined in this chapter. The shipboard testing will provide substantiating data for the chosen systems and will also provide such data as the MTBF for each of the five systems.

8. Based on the previous recommendations, RTN combatant ships should receive microprocessor installation.

9. After choosing a system, the RTN must ensure that proper purchase and maintenance contracts are used for implementing the chosen system.

APPENDIX A

TOTAL SCORE FOR EACH SYSTEM

SYSTEM	RELIABILITY (100)		MAINTENANCE (90)		HARDWARE (85)			
	Company	MTBF	Warranty	Service	Speed	Monitor	Keybord	Mass St.
Unix PC	0.75		0.60	0.90	0.90	0.90	0.95	0.70
A 486	0.70		0.60	0.70	0.75	0.95	0.90	0.95
B 25	0.85		0.70	0.70	0.75	0.95	0.80	0.85
ATS 8	0.75		N/A	0.60	0.75	0.80	0.75	1.00
CS-100	0.70		0.60	0.95	0.90	0.75	0.80	0.70
DBS-16	0.60		0.60	0.65	0.75	0.75	0.80	0.85
X - 16	0.60		0.60	0.65	0.75	0.75	0.80	0.85
Z -1750	0.65		0.70	0.85	0.90	0.80	0.75	N/A
GEMINI	0.65		0.95	0.70	1.00	N/A	N/A	0.95
IBM AT	1.00		0.95	1.00	0.60	0.85	0.90	1.00
DT - 20	0.60		0.60	0.65	0.90	0.80	0.80	0.70
1050 E	0.50		0.75	0.85	0.75	N/A	N/A	0.85
16/200	0.60		0.60	0.65	0.75	0.90	0.80	0.95
2000	0.70		N/A	0.60	0.75	0.85	0.80	0.85
DIMENSI	0.65		0.90	0.80	0.75	0.80	0.80	0.70
7350 A	0.70		0.60	0.65	0.75	0.85	0.85	0.70
10 - 30	0.85		0.60	0.60	0.70	0.85	0.80	0.70
40 - 50	0.85		0.60	0.60	0.70	0.85	0.80	0.70
420	0.60		0.90	0.60	0.95	1.00	0.90	0.85
440	0.60		0.90	0.60	0.95	1.00	0.90	0.85
BUS.PRO	0.85		1.00	0.90	0.60	0.70	0.95	0.95
APC	0.80		0.60	0.95	0.75	0.90	1.00	0.95
Z - 200	0.85		0.70	0.95	0.60	0.95	0.90	1.00

TOTAL SCORE FOR EACH SYSTEM (CONTD.)

S Y S TEM	SYSTEM COMPAT (80)		SYSTEM EXPANDABILTY (75)			S/W (70)	PHYSICAL(60)		TOTAL SCORE	
	Oper. System	Interface	RAM	Slots	Work sta.	Language	Size			
Unix PC	0.75	0.90	0.75	0.85	0.60	0.95	0.65		442	
A 486	0.75	0.95	0.70	0.50	0.65	0.90	0.95		438	
B 25	0.85	0.95	0.70	0.85	1.00	0.90	0.95		475	<===
ATS 8	0.65	0.85	0.65	0.50	0.95	0.60	0.75		399	
CS-100	0.75	0.90	0.85	0.85	0.80	1.00	0.80		453	
DBS-16	0.85	0.90	0.85	0.75	1.00	0.60	0.85		411	
X - 16	0.70	0.85	0.70	0.75	0.80	0.80	0.85		408	
Z -1750	0.65	0.85	0.70	0.70	0.90	0.75	0.80		422	
GEMINI	0.75	0.85	0.85	0.80	0.95	0.85	0.70		453	
IBM AT	0.85	0.95	0.80	0.85	0.65	0.95	0.70		497	<===
DT - 20	0.85	0.95	0.80	0.65	0.60	0.90	0.70		413	
1050 E	0.80	0.80	0.65	0.60	0.90	0.80	0.70		406	
16/200	0.95	0.85	0.75	0.90	0.85	0.85	0.80		431	
2000	0.85	0.85	0.70	0.70	0.65	0.60	0.95		411	
DIMENSI	0.75	0.85	0.65	1.00	1.00	0.90	0.65		439	
7350 A	0.75	0.85	0.80	0.60	0.70	0.85	0.70		411	
10 - 30	0.75	0.85	0.65	0.70	0.65	0.85	0.80		425	
40 - 50	0.75	0.85	0.65	0.65	0.65	0.85	0.80		424	
420	0.95	0.85	0.75	0.50	0.65	0.95	1.00		452	
440	0.95	0.85	0.90	0.50	0.95	0.95	0.65		442	
BUS.PRO	1.00	1.00	0.95	1.00	1.00	1.00	0.65		501	<===
APC	0.95	0.95	0.70	0.85	0.65	0.95	0.70		466	<===
Z - 200	0.70	0.95	1.00	0.75	0.60	0.80	0.85		464	<===

APPENDIX B

GLOSSARY/ACRONYM LIST

AC	Alternating Current
AP	Application Program
BASIC	Beginners All-purpose Symbolic Instruction Code
CCP	Communication Control Program
CIC	Combat Information Center
CPU	Control Processing Unit
CP/M	Control Program for Microcomputers
COBOL	Common Business Oriented Language
CODASYL	Conference on Data System Languages
CVT	Constant Voltage Transformer
DBMS	Database Management System
DBTG	Database Task Group
DSDD	Double Side Double Density
DDL	Data Definition Language
DML	Data Manipulation Language
DMS	Data Management System
DOS	Disk Operating System
E-R Model	Entity Relationship Model
FORTRAN	Formula Translation
KB	Kilo Byte
LISP	List Processing
LSI	Large Scale Integrated
MB	Mega Byte
MP/M	Monitor Control Program
MTBF	Mean Time Between Failures
MTTR	Mean Time to Repairs
PC	Personnel Computer
RAM	Random Access Memory
ROM	Read Only Memory

RTN	Republic of Turkish Navy
SDM	Semantic Data Model
SUADPS	Shipboard Uniform Automatic Data Processing System
SNAP-1	Shipboard Non-tactical Automated Data Processing Program 1
UPS	Uninterruptable Power Supply
VLSI	Very Large Scale Integrated
WPS	Word Processing System

LIST OF REFERENCES

1. Kroenke David M., Business Computer Systems and Introduction, Mitchell Publishing Inc. 1984.

2. Swaine, Michael, Freiberger, Paul, Fire in the Valley, Osborne/McGraw - Hill, 1984.

3. Feigenbaum, Edward, A., and McCorduck, Pamela, The Fifth Generation, Addison-Wesley Publishing Company, 1983.

4. Personnel and Training Analysis Office, Washington D.C, Shipboard Non-Tactical ADP Program (Snap 1 phase 2), Navy Training Pla NAVSEA 0511C, Washington Navy Yard, 1981.

5. Gary, Kuehn, "Snap 1, Phase 1," Access: The Navy Data Automation Review, Vol 2, No.3, p. 1, May-June 1979

6. Dollard, John, A., Ship-Initiated Microcomputer Applications: Lessons Learned, Navy Personnel Research and Development Center, San Diego, November 1982.

7. Friedt, Suzan, "Tempest Winner Announced," Chips Ahoy, Navy Regional Data Automation Center, NARDAC, Norfolk, VA. October 1984.

8. Walling, R. P., Development Plan for the Carrier Administrative Data System, Analytical Technology Applications Corporation, 23 October 1980.

9. Castro, Luis, Jay, Hanson, and Retting, Tom, Advanced Programmer's Guide, featuring dBASE 3 and dBASE 2, Ashton-Tate Culver City, CA, 1985.

10. Kroenke, David, Database Processing Fundamentals, Design, Implementation, Science Research Associates, Inc, 1983.

11. Aarons Richard, "Power-base," PC Magazine, pp. 223-224, september 4, 1984.

12. Hart, Glenn, A., "Salvo," PC Magazine, pp. 225-228, september 4, 1984.

13. Aarons, Richard, N., "DataFlex," PC Magazine, pp. 253-255 September 4 1984.

14. Phillips John, "Informix," PC Magazine, pp. 261-268, September 4 1984.

15. Hart, Glenn, A., "dBASE 3," PC Magazine, pp. 275-278, September 4, 1984.

16. Choe, Y., K., Implementation of Microcomputer Systems for the Republic of Korea's Naval Ships, Master Thesis, Naval Postgraduate School, Monterey, CA. March 1984.

17. Navy Personnel Research and Development Center NPRDC TR 85-14, The Zog Technology Demonstration Project: A System evaluation on USS Carl Vinson (CVN-70), San Diego, CA., Dec. 1984

18. Frankel, Al, "Uninterruptible Power Supplies," Computers and Electronics, pp. 84-87. October 1984.

19. Seymour, Jim, "New Modems: Is faster better ?",Today's Office, pp. 14-18 January 1986.

20. Data Sources, "Hardware Data Communications," Sperry Corporation, Forth quarter, 1985

21. DATAPRO, "All About Microcomputers," Datapro Research Corporation, August 1985.

22. Schaeffer, Howard, Data Center Operations, Prentice-Hall, INC. N.J. 1981.

23. DATAPRO, "All About Microcomputers," Datapro Research Corporation, July 1985.

24. Glatzer, Hal, Introduction to Word Processing, SYBEX Inc., Berkeley CA. 1981.

25. Data Sources, "Hardware Data Communications," Sperry Corporation, Fourth quarter 1985, PA, 19424.

26. Datapro Directory of Small Computers 1,2, "Personal Computers," Datapro Research Corporation, 1985-1986, Delran, NJ, 08075.

27. Osborne, Adam, Cook, Steve, and Todd, Gail, Business System Buyer's Guide, Osborne/Mac Graw-Hill, Berkeley, CA. 1984.

28. Semprez Rosemary, Account Representative, Letter Federal Systems Division 1800 Harrison Street, Suite 1200 Oakland, CA 93940, November 22, 1985.

BIBLIOGRAPHY

Benevy, David, "Tips on Selecting a Small Business Computer," Interface Age, January 1982.

Cashin, Jerry, "The Battle of Languages:BASIC, COBOL, Pascal, ADA," Small Systems World, 4/85.

Finkel, LeRoy, "Buying a Micro: What Every Educator Should Know," Electronic Learning, Jan/Feb 1982.

Laird, R., C., "Microcomputers- Present and Future," New Electronics, September 21 1982.

Leslie, R. Schmeltz, "Surviving the Computer Revolution," Desktop Computing, March 1982.

Mo, A., Mahmood, "Choosing Computer Services for Small Business," Journal of Systems Management, July, 1982.

Pogrow, Stanley, "Micro-Computerizing Your Paperwork: Easy, Economical, and Effective," Electronic Learning, September 1982.

Poppelbaum, T., L., "Match Your New Computer to Your Needs," On Computing Inc., Summer 1981.

Rushinek, Avi, and Rushinek, Sara, F., "An evaluation of Mini/Micro systems: An Emperical Multivariant Analysis," Data Base, Summer 1983.

Stocdale. C., Stanley, "Design and Selection of Shipboard Microcomputer Systems," Marine Technology, January 1983.

INITIAL DISTRIBUTION LIST

		No. Copies
1.	Defense Technical Information Center Cameron Station Alexandria, Virginia 22304-6145	2
2.	Library, Code 0142 Naval Postgraduate School Monterey, California 93943	2
3.	Computer Technology Programs, Code 37 Naval Postgraduate School Monterey, California 93943	1
4.	LCDR Paul W. Callahan, Code 52CS Department of Computer Science Naval Postgraduate School Monterey, California 93943	1
5.	Professor John W. Creighton, Code 54CF Department of Administrative Science Naval Postgraduate School Monterey, California 93943	1
6.	LTJG. Sukru Ozkan Parseller Cumhuriyet Mah. Nurlu Sok. No 1 Bakirkoy, Istanbul / TURKEY	1
7.	Deniz Kuvvetleri Komutanligi Kutuphanesi Bakanliklar, Ankara / TURKEY	5
8.	Donanma Komutanligi Kutuphanesi Golcuk, Izmit / TURKEY	1
9.	Golcuk Ana Us Komutanligi Kutuphanesi Golcuk, Izmit / TURKEY	1
10.	Deniz Egitim Merkezi Komutanligi Kutuphanesi Karamursel, Kocaeli / TURKEY	1
11.	Harp Academileri Komutanligi Kutuphanesi Ayazaga, Istanbul / TURKEY	1
12.	Deniz Harp Okulu Komutanligi Kutuphanesi Tuzla, Istanbul / TURKEY	1
13.	Deniz Lisesi Komutanligi Kutuphanesi Heybeliada, Istanbul / TURKEY	1

217825

Thesis
09972
c.1

Ozkan

Implementation and evaluation of microcomputer systems for the Republic of Turkey's naval ships.